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The National Forest Heritage of the Altai-Sayan Ecoregion

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Abstract. The article presents the methodology of the selection and ranking Intact Forest Landscapes of the Altai-Sayan Ecoregion. This method is developed to identify the most valuable areas of forests, which currently does not legally protect. These areas are planned to recommend for inclusion in the National Forest Heritage of Russia.

Keywords: Hierarchy's analysis method, remote sensing, biodiversity, forest protection.

Introduction. In 2012 the Federal Forestry Agency submitted a proposal to establish the National Forest Heritage (hereinafter NFH), including the forest habitats of national-level priority, and it was stated in the Basic Principles of State Policy of use, preservation, protection and reproduction of forests in the Russian Federation for the period up to 2030. To preserve these areas, it is planned to exclude them from economic use.

The most suitable areas for establishing the NFH are Intact Forest Landscapes (hereinafter IFL) - large natural areas of forests with no signs of significant human activity, not less than 50 hectares, not containing settlements, functional transportation communications or any other kinds of anthropogenic influence. Such territories conserve biodiversity at a nationwide scale and maintain viable population of the species including large carnivores and ungulate migration routes. These areas are also crucial for ecological services that forests provide. Besides IFL, the smaller forest areas of outstanding universal value are also to be included in the national forest heritage. Such smaller areas serve the purposes stated above as well as contain objects of historical, scientific or cultural significance [2].

Due to industrial logging, mining operations, infrastructure construction, fires (mostly anthropogenic), the IFL areas in the Altai-Sayan Ecoregion as well as the whole Russia are decreasing.

Nowadays there's an acute problem of preserving the large significant forest habitats not exposed to the anthropogenic impact. They are weakly protected by legally approved mechanisms (various categories of specially protected natural areas, protective and reserve forests), and the categories of high conservation value forests (hereinafter HCVF), providing protection status under the voluntary forest certification under FSC scheme; so other mechanisms for their protection have to be used. The priority now is to preserve them as the National Forest Heritage of Russia [1].



The aim of this publication is to identify the most significant forest habitats in the the Altai-Sayan Ecoregion, which are not protected by law against deforestation for commercial purposes and adjoin fire-exposed areas and logging areas - they must be recommended to be preserved as the National Forest Heritage of Russia.

Identifying the forest habitats suitable to be included in the National Forest Heritage

To identify the legally unprotected IFL areas in the Altai-Sayan Ecoregion, suitable for including in the NFH, it's necessary to exclude protective forests and specially protected natural areas from the list.

The information about the IFL borders of 2013 was supplied by data portal "Valuable forests of Russia" based on the software product by the engineering and technical centre "SCANEX" GeoMixer and is available at <http://forest.kosmosnimki.ru> The borders of the protective forests and specially protected natural areas in the Altai-Sayan Ecoregion were identified by means of vectorization of index maps on a scale of 1:100 000 – 1:300 000. The protective forests were divided into the following categories: restricted belts of forests next to water bodies; forests alongside spawning ground; forests in water protective zones; forests in pine-nut harvesting areas; anti-erosion forests; forests located in forest, located in the desert, semi-desert, forest-steppe, forest-tundra zones, steppes, mountains (category 2, 4b, 4c, 4d, 4h and 4i according to Art. 102 of the Forestry Code of the Russian Federation).

After specially protected natural areas and protective forests had been excluded from IFL areas, the forests habitats with no legal protection were identified - so called "uncovered territories". These habitats were subsequently considered most suitable to be included in the National forest heritage. The total area of these habitats in the Russian part of the Altai-Sayan Ecoregion is more than 11.5 million hectares. The half of the total area (about 6.5 million hectares) is located in the Republic of Tuva, vast areas (more than 1 million hectares) are located in the Krasnoyarsk Territory and Irkutsk Region.

Allocating the forest habitats suitable for including in the national forest heritage

For allocating the IFL areas to be included in the National Forest Heritage in the Altai-Sayan Ecoregion, the procedure was developed, taking into account specific features of forest ecosystems.

The basic NFH's criteria are:

- areas are the IFL of Russia;
- forests habitats with a high level of biodiversity identified in the framework of international programmes of the biodiversity areas identification;
- forests of scientific or historical significance (protective forests categories).

Identification of the areas to be included in the NFH was based on the analytic hierarchy process. The 4-level incomplete dominance hierarchy of evaluation criteria was used for this. The following determinant were used as a basis for the evaluation criteria:

- 1) the value of the territory determined by one of two factors: areas with high levels of biodiversity (habitat and migration of rare animal species, important bird and plant areas), or areas with scientific or historical value;
- 2) the possible anthropogenic threats to the ecological stability of the territory (fires, deforestation, the implementation of large investment projects).

The significance of the aggregate evaluation criteria was calculated using a paired comparison method. While selecting habitats, the methods of spatial analysis for the geographic information system (hereinafter GIS) were used.

The information about the value of areas was obtained from the literature (regional Red Books, the list of Important Bird and Plant Areas (hereinafter IPAs) in the Altai-Sayan Ecoregion [3], etc.), raster and vector maps of habitats of rare species downloaded from the Internet, raster index maps of the forests of scientific or historical significance.

Using the above stated methods within the "uncovered" IFL in the Altai-Sayan Ecoregion, the areas of high conservation value (habitat and migration of rare animal species, important bird and plant areas) as well as the areas of a scientific / historical significance were identified.

The information about the possible anthropogenic threats has been obtained from remote sensing data (satellite Landsat series, Aqua / Terra, SAS Planet program), from the literature, as well as the official websites data on the planned construction of oil and gas pipelines, railways and roads.

The following types of violations threatening conservation of the IFLs in the Altai-Sayan Ecoregion were identified:

- anthropogenic fires;
- logging;
- planned and existing railways;
- planned oil and gas pipelines;
- mining activities;
- recreational impact.

Interpretation of forest areas-victims of forest fires, logging, road construction and mining activities, is based on the spectral response characteristics of the geological substrate [4,5] obtained by the Landsat satellite data, as well as detected by visual interpretation of high-resolution recording (pixel size of 1-5 m) obtained in SASPlanet system.

Another factor threatening the IFLs is areas accessibility (roads which ensure access to forests, population density). The establishment of the 10 km buffer zone around the highways and railways allowed to mitigate their anthropogenic threat. The establishment of the 20 km buffer zone around most-visited tourist places allowed to mitigate recreational impact on the forest ecosystems. The population density was estimated according to statistics.

The GIS analysis of the location of the factors threatening the IFLs' conservation, as well as the areas with high conservation value, made it possible to identify the IFL territories, which are likely to be lost in the near future and can be recommended for inclusion in the NFH. The total area of the habitats recommended to be included in the National Forest Heritage amounts to 1.912 million hectares.

The identified forest habitats were ranked. The threats and values available in every habitat were taken into account, while ranking. The principles of ranking the areas are in the Table 1.

Table 1.

Rank	Values	Threats	Accessibility (roads, population density)
1	The high density of values (habitats for flagship species, important bird areas (hereinafter IBA), habitats for the Red List species)	The high level of threats (the implementation of large infrastructure projects)	High
2	Values available	Threats available	Lack of roads and the high population density
3	Values available	No threats	Lack of roads and the low population density

12 forest habitats recommended to be included in the NFH were identified in the Altai-Sayan Ecoregion. All of them were divided into three levels of conservation significance (equal to the ranks 1-3 in the table 1).

The field research of the forest habitats suitable to be included in the national forest heritage

Field research was conducted to verify that the identified areas are to be included in the NFH. Taking into account transport access and work schedule, 6 areas in the Krasnoyarsk Territory, the Kemerovo Region and the Republic of Tyva were chosen for the field research.

During the field research the temporary sample plots were established according to the statutory requirements of the Industrial Standard 16128-90 "Sample areas for forest management, the methods of establishing". There is a description for every sample plot:

- General characteristics of a plot (angle of slope, exposure, shape, representativeness);
- Forest valuation characteristics of planting (species composition, average diameter, average height, density, the average age of each species, after-growth, shrub layer);
- Significant objects found at the plots (large tree windfall at a different stage of decomposition; individual dry and dead hard- and softwood, high stumps, broken at different heights (stubs); single large old-growth and non-standard trees, trees with nests and hollows; animal shelter; large anthills; natural solonchic soils).

As a result of the laboratory study of the data obtained from the field research, it was identified that the plots contain the plantations of natural origin where the coniferous trees (fir, cedar, larch) prevail. General condition of the forest stands is satisfactory - within the established sample plots there are no dead coniferous trees, insects on trunks, heart rot in the taken samples. No any business activity is conducted on the researched plots - they are the significant territories with a high level of the natural biodiversity. The plots are the forest ecosystems capable of self-maintenance for indefinitely long time (there were defined age grades from middle-aged to mature).

The Results

Applying the methodological framework of the NFH concept, the regional methodology of evaluation of the intact forest habitats environmental significance was developed, considering conservation of forest biodiversity. The 4-level incomplete dominance hierarchy of evaluation criteria was applied; it allows to rank the habitats for biodiversity conservation.

According to the developed regional methodology, the IFL areas in the Altai-Sayan Ecoregion were identified and ranked for inclusion in the National Forest Heritage. The vector polygon layer of the potential areas to be included in the NFH was prepared with all the necessary attributive information.

The field research allows to prove the applicability of the methodology we developed for the identification the NFH habitats in the Altai-Sayan Ecoregion. It was identified that the plots chosen for research consist of the plantations of natural origin where the coniferous trees prevail. The plots are the forest ecosystems capable of self-maintenance for indefinitely long time (the age grades from middle-aged to mature) and the significant territories with a high level of the natural biodiversity.

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